CLAIMS

Now, therefore, at least the following is claimed:

1. A method for a spread spectrum detector, comprising the steps of:

receiving a spread spectrum modulated signal having a Doppler shift error imposed by movement between a signal source and receiver;

producing a plurality of complex first correlation values based upon the signal and a code;

generating a plurality of complex second correlation values respectively from the first correlation values using a fast fourier transform, the second correlation values being phase shifted by respective different amounts from corresponding first correlation values, so that the second correlation values exhibit less of the Doppler shift error than the first correlation values; and

combining the complex second correlation values to derive a complex third correlation value that indicates a degree of correspondence of the code with the signal.

2. The method of claim 1, further comprising the steps of:

performing the producing, generating, and combining steps a plurality of times with a different code phase of the code each time in order to produce a plurality of third correlation values; and

determining that a particular one of the code phases corresponds to the signal based upon the third correlation values.

3. The method of claim 1, wherein the producing step comprises the steps of:

multiplying chips of the code with signal samples, respectively, to derive multiplication results; and

adding together the multiplication results to produce the first correlation values.

4. The method of claim 1, further comprising the steps of:

storing the first correlation values in a memory; and

communicating the first correlation values from the memory to combinational logic that implements the fast fourier transform.

5. The method of claim 1, further comprising the steps of:

performing the producing step a plurality of times with a different code phase of the code each time in order to produce more than one plurality of first correlation values, one corresponding with each of the different code phases;

storing each plurality of first correlation values in a memory; and

performing the generating step upon each plurality of first correlation values, one at a time, so as to create a plurality of second correlation values for each code phase.

6. The method of claim 1, wherein the second correlation values are combined coherently in the combining step so that the third correlation value comprises a real number part and an imaginary number part, which are collectively indicative of a magnitude and a phase.

7. The method of claim 1, wherein the second correlation values are combined noncoherently in the combining step so that the third correlation value comprises a magnitude.

8. The method of claim 1, wherein the producing step comprises the step of using a matched filter to produce the first correlation values.

9. The method of claim 1, wherein the producing step comprises the step of using a digital signal processor to produce the correlation value.

10. The method of claim 1, wherein the signal is received from a satellite associated with a global positioning system.

11. The method of claim 1, wherein the signal is a carrier signal modulated with a repeating code.

12. The method of claim 2, wherein the determining step is performed by a processor.

13. A spread spectrum detector, comprising:

first means for receiving a spread spectrum modulated signal having a Doppler shift error imposed by movement between a signal source and receiver;

second means for producing a plurality of complex first correlation values based upon the signal and a code;

third means for generating a plurality of complex second correlation values respectively from the first correlation values by implementing a fast fourier transform, the second correlation values being phase shifted by respective different amounts from corresponding first correlation values, so that the second correlation values exhibit less of the Doppler shift error than the first correlation values; and

fourth means for combining the second correlation values to derive a third correlation value that indicates a degree of correspondence of the code with the signal.

14. The detector of claim 13, further comprising:

fifth means for determining that a code phase of the code corresponds to the signal based upon the third correlation value.

15. The detector of claim 13, wherein the second means comprise:

means for multiplying chips of the code with signal samples, respectively, to derive multiplication results; and

means for adding together the multiplication results to produce the first correlation values.

16. The detector of claim 13, wherein the third means further comprises:

means for producing first correlation values with a different code phase of the code each time in order to produce more than one plurality of first correlation values, one corresponding with each of the different code phases;

means for storing each plurality of the first correlation values in a memory; and

means for generating a plurality of second correlation values for each plurality of first correlation values, each plurality of second correlation values corresponding to a respective code phase.

17. The detector of claim 13, wherein the fourth means comprises a means for coherently combining the second correlation values together so that the third correlation value comprises a real number part and an imaginary number part, which are collectively indicative of a magnitude and a phase.

18. The detector of claim 13, wherein the fourth means comprises a means for noncoherently combining the second correlation values together so that the third correlation value comprises a magnitude and no phase information.

19. The detector of claim 13, wherein the second means comprises a matched filter means for producing the first correlation values.

20. The detector of claim 13, wherein the second means comprises a digital signal processing means for producing the first correlation values.

21. The detector of claim 13, wherein the signal is received from a satellite associated with a global positioning system.

22. The detector of claim 13, wherein the signal is a carrier signal modulated with a repeating code.

23. The detector of claim 13, wherein the third means comprises:

means for storing the first correlation values in a memory; and

means for communicating the first correlation values from the memory to combinational logic that implements the fast fourier transform.

24. A spread spectrum detector, comprising:

a receiver configured to receive a spread spectrum modulated signal having a Doppler shift error imposed by movement between a signal source and receiver;

a multiplier configured to produce a plurality of complex first correlation values based upon the signal and a code;

a fast fourier phase shifter configured to generate a plurality of complex second correlation values respectively from the first correlation values using a fast fourier transform, the second correlation values being phase shifted by respective different amounts from corresponding first correlation values, so that the second correlation values exhibit less of the Doppler shift error than the first correlation values; and

an integrator configured to integrate the second correlation values to derive a third correlation that indicates a degree of correspondence of the code with the signal.

25. The detector of claim 24, further comprising:

a processor programmed to determine that a particular one of code phases of the code corresponds to the signal based upon the third correlation value.

26. The detector of claim 24, wherein the multiplier comprises:

a plurality of multipliers configured to multiply chips of each code phase with signal samples, respectively, to derive multiplication results; and

a plurality of adders configured to add together the multiplication results to produce the first correlation values.

27. The detector of claim 24, wherein the multiplier is configured to produce first correlation values with a different code phase of the code each time in order to produce more than one plurality of first correlation values, one corresponding with each of the different code phases; and wherein the multiplier is adapted to store each plurality of the first correlation values in a memory; and further comprising means for generating a plurality of second correlation values for each plurality of first correlation values, each plurality of second correlation values corresponding to a respective code phase.

28. The detector of claim 24, wherein the integrator is configured to coherently combine the second correlation values together so that the third correlation value comprises a real number part and an imaginary number part, which are collectively indicative of a magnitude and a phase.

29. The detector of claim 24, wherein the integrator is configured to noncoherently combine the second correlation values together so that the third correlation value comprises a magnitude and no phase information.

30. The detector of claim 24, wherein the multiplier comprises a matched filter configured to produce the first correlation values.

31. The detector of claim 24, wherein the multiplier comprises a digital signal processor to produce the first correlation values.

32. The detector of claim 24, wherein the signal is received from a satellite associated with a global positioning system.

33. The detector of claim 24, wherein the signal is a carrier signal modulated with a repeating code.

34. A computer readable medium having a program, the program comprising:

first logic to receive a spread spectrum modulated signal having a Doppler shift error imposed by movement between a signal source and receiver;

second logic to produce a plurality of complex first correlation values based upon the signal and a code;

third logic to generate a plurality of complex second correlation values respectively from the first correlation values by implementing a fast fourier transform, the second correlation values being phase shifted by respective different amounts from corresponding first correlation values, so that the second correlation values exhibit less of the Doppler shift error than the first correlation values; and

fourth logic to combine the second correlation values to derive a third correlation value that indicates a degree of correspondence of the code with the signal.

35. The computer readable medium of claim 34, further comprising:

fifth logic to determine that a code phase of the code corresponds to the signal based upon the third correlation value.

36. The computer readable medium of claim 34, wherein the second logic comprises:

logic to multiply chips of the code with signal samples, respectively, to derive multiplication results; and

logic to add together the multiplication results to produce the first correlation values.

37. The computer readable medium of claim 34, wherein the third logic further comprises:

logic to produce first correlation values with a different code phase of the code each time in order to produce more than one plurality of first correlation values, one corresponding with each of the different code phases;

logic to store each plurality of the first correlation values in a memory; and

logic to generate a plurality of second correlation values for each plurality of first correlation values, each plurality of second correlation values corresponding to a respective code phase.

38. The computer readable medium of claim 34, wherein the fourth logic comprises logic to coherently combine the second correlation values together so that the third correlation value comprises a real number part and an imaginary number part, which are collectively indicative of a magnitude and a phase.

39. The computer readable medium of claim 34, wherein the fourth logic comprises logic to noncoherently combine the second correlation values together so that the third correlation value comprises a magnitude and no phase information.

40. The computer readable medium of claim 34, wherein the signal is received from a satellite associated with a global positioning system.

41. The computer readable medium of claim 34, wherein the signal is a carrier signal modulated with a repeating code.

42. A GPS receiver, comprising:

a first GPS antenna coupled to a digital memory, the digital memory storing first digitized signals obtained through the first GPS antenna;

a second GPS antenna coupled to the digital memory, the digital memory storing second digitized signals obtained through the second GPS antenna;

a digital processor coupled to the digital memory, the digital processor processing the first digitized signals after being stored in the digital memory to provide first position information and processing the second digitized signals after being stored in the digital memory to provide second position information;

a receiver configured to receive a spread spectrum modulated signal having a Doppler shift error imposed by movement between a signal source and receiver;

a multiplier configured to produce a plurality of complex first correlation values based upon the signal and a code; and

a phase shifter configured to generate a plurality of complex second correlation values respectively from the first correlation values using a fast fourier transform (FFT), the second correlation values being phase shifted by respective different amounts from corresponding first correlation values, so that the second correlation values exhibit less of the Doppler shift error than the first correlation values; and

an integrator configured to integrate the second correlation values to derive a third correlation value that indicate a degree of correspondence of the code with the signal.

43. A method of operating a GPS receiver, the method comprising:

receiving first GPS signals through a first GPS antenna;

digitizing the first GPS signals to provide first digitized signals and storing the first digitized signals in a first digital memory;

receiving second GPS signals through a second GPS antenna;

digitizing the second GPS signal to provide second digitized signals and storing the second digitized signals in one of the first digital memory and a second digital memory;

processing in a digital processor the stored first digitized signals to provide a first position information and processing the stored second digitized signals to provide a second position information;

selecting one of the first position information and the second position information to provide a selected position information;

when performing the processing step, performing the following steps upon each of the first and second GPS signals:

producing a plurality of complex first correlation values based upon the signal and a code;

generating a plurality of complex second correlation values respectively from the first correlation values using a fast fourier transform (FFT), the second correlation values being phase shifted by respective different amounts from corresponding first correlation values, so that the second correlation values exhibit less of the Doppler shift error than the first correlation values; and

combining the second correlation values to derive a complex third correlation value that indicates a degree of correspondence of the code with the signal.

44. A method for determining a position of a mobile global positioning system receiver, the mobile global positioning system receiver receiving global positioning system signals from at least one of a plurality of global positioning system (GPS) satellites, the method comprising:

receiving a cellular communication signal in a mobile communication receiver coupled to the mobile global positioning system receiver, the cellular communication signal having a time indicator which represents a time event;

associating the time indicator with data representing a time of arrival of a GPS satellite signal at the mobile global positioning system receiver;

determining position information of the mobile global positioning system receiver, wherein the data representing the time of arrival of the GPS satellite signal and the time indicator are used to determine the position information of the mobile global positioning system receiver and wherein the cellular communication signal supports 2-way communications; and

when performing the determining step, performing the following steps:

producing a plurality of complex first correlation values based upon a signal and a code;

generating a plurality of complex second correlation values respectively from the first correlation values using a fast fourier transform (FFT), the second correlation values being phase shifted by respective different amounts from corresponding first correlation values, so that the second correlation values exhibit less of the Doppler shift error than the first correlation values; and

combining the second correlation values to derive a complex third correlation value that indicates a degree of correspondence of the code with the signal.

45. A method of operating a global positioning system (GPS) receiver, comprising:

sensing whether GPS signals are capable of being received from GPS satellites and providing an activation signal when GPS signals are capable of being received;

maintaining the GPS receiver in a low power state;

activating the GPS receiver from the lower power state upon detecting the activation signal;

producing a plurality of complex first correlation values based upon a GPS signal and a code;

generating a plurality of complex second correlation values respectively from the first correlation values using a fast fourier transform (FFT), the second correlation values being phase shifted by respective different amounts from corresponding first correlation values, so that the second correlation values exhibit less of the Doppler shift error than the first correlation values; and

combining the second correlation values to derive a complex third correlation value that indicates a degree of correspondence of the code with the signal.

46. A method for using a dual mode GPS receiver, the method comprising the steps of:

activating the GPS receiver in a first mode of operation including,

receiving GPS signals from in view satellites;

downconverting and demodulating the GPS signals to extract Doppler information regarding in view satellites and to compute pseudorange information;

storing the Doppler information;

detecting when the GPS receiver is experiencing blockage conditions and activating a second mode of operation in response thereto, the second mode including, digitizing the GPS signals at a predetermined rate to produce sampled GPS signals; and

receiving a signal having a Doppler shift error imposed by movement between a signal source and the GPS receiver;

producing a plurality of complex first correlation values based upon the signal and a code;

generating a plurality of complex second correlation values respectively from the first correlation values using a fast fourier transform (FFT), the second correlation values being phase shifted by respective different amounts from corresponding first correlation values, so that the second correlation values exhibit less of the Doppler shift error than the first correlation values; and

combining the second correlation values to derive a complex third correlation value that indicates a degree of correspondence of the code with the signal.

47. In a method for determining the position of a remote unit, a process comprising:

receiving, at the remote unit from a transmission cell in a cellular communication system, a Doppler information of a satellite in view of the remote unit;

computing, in the remote unit, position information for the satellite by using the Doppler information without receiving and without using satellite ephemeris information;

when computing the position information, performing the following steps:

producing a plurality of complex first correlation values based upon a received signal and a code;

generating a plurality of complex second correlation values respectively from the first correlation values using a fast fourier transform (FFT), the second correlation values being phase shifted by respective different amounts from corresponding first correlation values, so that the second correlation values exhibit less of the Doppler shift error than the first correlation values; and

combining the second correlation values to derive a complex third correlation value that indicates a degree of correspondence of the code with the signal.

48. A method of using a base station for providing a communications link to a mobile GPS unit, the method comprising:

determining Doppler information of a satellite in view of the mobile GPS unit, wherein the Doppler information is used by the mobile GPS unit to determine a position information for the satellite;

transmitting from a transmission cell in a cellular communication system the Doppler information of the satellite in view to the mobile GPS unit wherein the mobile GPS unit determines the position information without receiving and without using satellite ephemeris information;

when performing the determining step, performing the following steps:

receiving a signal having a Doppler shift error imposed by movement between a satellite and a GPS receiver producing a plurality of complex first correlation values based upon the signal and a code;

generating a plurality of complex second correlation values respectively from the first correlation values using a fast fourier transform (FFT), the second correlation values being phase shifted by respective different amounts from corresponding first correlation values, so that the second correlation values exhibit less of the Doppler shift error than the first correlation values; and

combining the second correlation values to derive a complex third correlation value that indicates a degree of correspondence of the code with the signal.

49. A method of determining the location of a remote object, comprising the steps of:

transporting a positioning sensor to a remote object;

repositioning the positioning sensor to a fix position such that the positioning sensor is capable of receiving positioning signals, the fix position being in a known position relative to the position of the remote sensor;

storing a predetermined amount of data in the positioning sensor while the positioning sensor is located at the fix position, the data comprising the positioning signals;

processing the data to determine the location of the fix position;

computing the location of the remote object using the location of the fix position; and

when performing the processing step, performing the following steps:

producing a plurality of complex first correlation values based upon the signal and a code;

generating a plurality of complex second correlation values respectively from the first correlation values using a fast fourier transform (FFT), the second correlation values being phase shifted by respective different amounts from corresponding first correlation values, so that the second correlation values exhibit less of the Doppler shift error than the first correlation values; and

combining the second correlation values to derive a complex third correlation value that indicates a degree of correspondence of the code with the signal.

50. A method of tracking a remote object comprising the steps of:

fitting a remote object with a positioning sensor configured to receive and store positioning information when the remote object is in a fix position;

positioning the remote object in a fix position such that the positioning sensor is capable of detecting an activation signal;

receiving and storing a predetermined amount of data in the positioning sensor, the data comprising positioning information;

processing the data to determine the location of the fix position;

when processing the data, performing the following steps:

producing a plurality of complex first correlation values based upon the signal and a code;

generating a plurality of complex second correlation values respectively from the first correlation values using a fast fourier transform (FFT), the second correlation values being phase shifted by respective different amounts from corresponding first correlation values, so that the second correlation values exhibit less of the Doppler shift error than the first correlation values; and

combining the second correlation values to derive a complex third correlation value that indicates a degree of correspondence of the code with the signal.

51. A computer readable medium containing a computer program having executable code for a GPS receiver, the computer program comprising:

first instructions for receiving GPS signals from in view satellites, the GPS signals comprising pseudorandom (PN) codes;

second instructions for digitizing the GPS signals at a predetermined rate to produce sampled GPS signals;

third instructions for storing the sampled GPS signals in a memory; and

fourth instructions for processing the sampled GPS signals by performing a plurality of convolutions on the sampled GPS signals, the processing comprising performing the plurality of convolutions on a corresponding plurality of blocks of the sampled GPS signals to provide a plurality of corresponding results of each convolution and summing a plurality of mathematical representations of the plurality of corresponding results to obtain a first position information; and

wherein the fourth instructions are designed to:

produce a plurality of complex first correlation values based upon the signal and a code, ;

generate a plurality of complex second correlation values respectively from the first correlation values using a fast fourier transform (FFT), the second correlation values being phase shifted by respective different amounts from corresponding first correlation values, so that the second correlation values exhibit less of the Doppler shift error than the first correlation values; and

combine the second correlation values to derive a complex third correlation value that indicates a degree of correspondence of the code with the signal.

52. A computer readable medium containing an executable computer program for use in a digital processing system, the executable computer program when executed in the digital processing system causing the digital processing system to perform the steps of:

performing a plurality of convolutions on a corresponding plurality of blocks of sampled GPS signals to provide a plurality of corresponding results of each convolution;

summing a plurality of mathematical representations of the plurality of corresponding results to obtain a first position information.

when performing the plurality of convolutions step, performing at least the following steps:

producing a plurality of complex first correlation values based upon the signal and a code;

generating a plurality of complex second correlation values respectively from the first correlation values using a fast fourier transform (FFT), the second correlation values being phase shifted by respective different amounts from corresponding first correlation values, so that the second correlation values exhibit less of the Doppler shift error than the first correlation values; and

combining the second correlation values to derive a complex third correlation value that indicates a degree of correspondence of the code with the signal.

53. A method of calibrating a local oscillator in a mobile GPS receiver, the method comprising:

receiving a precision carrier frequency signal from a source providing the precision carrier frequency signal;

automatically locking to the precision carrier frequency signal and providing a reference signal;

calibrating the local oscillator with the reference signal, the local oscillator being used to acquire GPS signals;

receiving a signal having a Doppler shift error imposed by movement between a signal source and the GPS receiver;

producing a plurality of complex first correlation values based upon the signal and a code;

generating a plurality of complex second correlation values respectively from the first correlation values using a fast fourier transform (FFT), the second correlation values being phase shifted by respective different amounts from corresponding first correlation values, so that the second correlation values exhibit less of the Doppler shift error than the first correlation values; and

combining the second correlation values to derive a complex third correlation value that indicates a degree of correspondence of the code with the signal.

54. A method of using a base station to calibrate a local oscillator in a mobile GPS receiver, the method comprising:

producing a first reference signal having a precision frequency;

modulating the first reference signal with a data signal to provide a precision carrier frequency signal;

transmitting the precision carrier frequency signal to the mobile GPS receiver, the precision carrier frequency signal being used to calibrate a local oscillator in the mobile GPS receiver, the local oscillator being used to acquire GPS signals;

receiving a spread spectrum signal having a Doppler shift error imposed by movement between a signal source and the GPS receiver;

producing a plurality of complex first correlation values based upon the signal and a code;

generating a plurality of complex second correlation values respectively from the first correlation values using a fast fourier transform (FFT), the second correlation values being phase shifted by respective different amounts from corresponding first correlation values, so that the second correlation values exhibit less of the Doppler shift error than the first correlation values; and

combining the second correlation values to derive a complex third correlation value that indicates a degree of correspondence of the code with the signal.

55. A method of deriving a local oscillator signal in a mobile GPS receiver, the method comprising:

receiving a precision carrier frequency signal from a source providing the precision carrier frequency signal;

automatically locking to the precision carrier frequency signal and providing a reference signal;

using the reference signal to provide a local oscillator signal to acquire GPS signals;

receiving a spread spectrum signal having a Doppler shift error imposed by movement between a signal source and the GPS receiver;

producing a plurality of complex first correlation values based upon the signal and a code;

generating a plurality of complex second correlation values respectively from the first correlation values using a fast fourier transform (FFT), the second correlation values being phase shifted by respective different amounts from corresponding first correlation values, so that the second correlation values exhibit less of the Doppler shift error than the first correlation values; and

combining the second correlation values to derive a complex third correlation value that indicates a degree of correspondence of the code with the signal.

56. A method of processing position information, the method comprising:

receiving SPS signals from at least one SPS satellite;

transmitting cell based communication signals between a communication system coupled to the SPS receiver and a first cell based transceiver which is remotely positioned relative to the SPS receiver wherein the cell based communication signals are wireless;

determining a first time measurement which represents a time of travel of a message in the cell based communication signals in a cell based communication system which comprises the first cell based transceiver and the communication system;

determining a second time measurement which represents a time of travel of the SPS signals;

determining a position of the SPS receiver from at least the first time measurement and the second time measurement, wherein the cell based communication signals are capable of communicating data messages in a two-way direction between the first cell based transceiver and the communication system; and

performing the following steps during at least one of the determining steps:

producing a plurality of complex first correlation values based upon a signal and a code;

generating a plurality of complex second correlation values respectively from the first correlation values using a fast fourier transform (FFT), the second correlation values being phase shifted by respective different amounts from corresponding first correlation values, so that the second correlation values exhibit less of the Doppler shift error than the first correlation values; and

combining the second correlation values to derive a complex third correlation value that indicates a degree of correspondence of the code with the signal.

57. A method of processing position information in a digital processing system, the method comprising:

determining a first time measurement which represents a time of travel of a message in cell based communication signals in a cell based communication system which comprises a first cell based transceiver which communicates with the digital processing system and a communication system which communicates in a wireless manner with the first cell based transceiver;

determining a position of a SPS receiver from at least the first time measurement and a second time measurement which represents a time of travel of SPS signals received at the SPS receiver which is integrated with the communication system and is remotely located relative to the first cell based transceiver and the digital processing system, wherein the cell based communication signals are capable of communicating messages from the communication system to the first cell based transceiver; and

performing the following steps when determining the position:

receiving a signal having a Doppler shift error imposed by movement between a signal source and the GPS receiver;

producing a plurality of complex first correlation values based upon an SPS signal and a code;

generating a plurality of complex second correlation values respectively from the first correlation values using a fast fourier transform (FFT), the second correlation values being phase shifted by respective different amounts from corresponding first correlation values, so that the second correlation values exhibit less of the Doppler shift error than the first correlation values; and

combining the second correlation values to derive a complex third correlation value that indicates a degree of correspondence of the code with the signal.

58. A method of controlling a communication link and processing data representative of GPS signals from at least one satellite in a GPS receiver, the method comprising:

processing the data representative of GPS signals from at least one satellite in a processing unit, including performing a correlation function to determine a pseudorange based on the data representative of GPS signals;

controlling communication signals through the communication link by using the processing unit to perform the controlling and wherein the processing unit performs demodulation of communication signals sent to the GPS receiver; and

when performing the processing step, performing at least the following steps:

receiving a GPS signal having a Doppler shift error imposed by movement between a signal source and the GPS receiver;

producing a plurality of complex first correlation values based upon the signal and a code;

generating a plurality of complex second correlation values respectively from the first correlation values using a fast fourier transform (FFT), the second correlation values being phase shifted by respective different amounts from corresponding first correlation values, so that the second correlation values exhibit less of the Doppler shift error than the first correlation values; and

combining the second correlation values to derive a complex third correlation value that indicates a degree of correspondence of the code with the signal.